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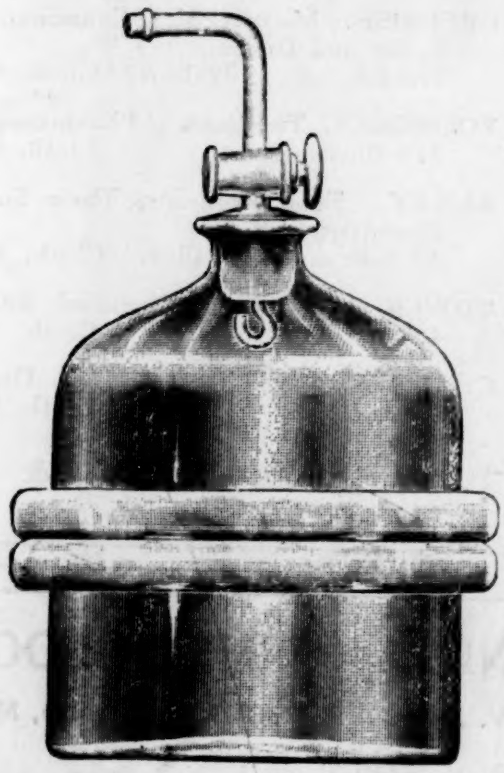

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SOME CHEMICAL BEARINGS OF PHARMACOLOGY[1]

PROBABLY the best definition of pharmacology is that which describes it as the study of the action of chemical substances upon living things. Pharmacological problems, therefore, fall into three groups, namely, those which relate (1) to the chemical substances (usually drugs or poisons), (2) to the living things (which may be anything from simple cells to highly complex organisms), and (3) to the reaction between the one and the other. Evidently then a pharmacological problem without a chemical bearing must indeed be superficial.

With regard to the problems of the first group—those relating solely to the chemistry of pharmacological agents—I will call your attention to a chemical classification of drugs which appears to differ from any which have previously been suggested. It should be of interest to every chemist desiring to advance our knowledge of drugs. In the following classes are included only substances whose value in the treatment of disease is at present above question, or likely to be soon established. Suggestiveness rather than completeness is the intent of this presentation.

A CLASSIFICATION OF PHARMACOLOGICAL AGENTS ACCORDING TO THE STATE OF PRESENT KNOWLEDGE OF THEIR CHEMISTRY

1. Substances from which no pure chemical principle has as yet been isolated:
   - Pituitary
   - Insulin
   - Secretin
   - Anti-venoms
   - Anti-toxins
2. Substances which contain definitely isolated chemical principles, but which are employed by preference in impure forms empirically found more effective:
   - Digitalis
   - (Digitoxin

[1] An address before the McGill Chemical Society, December 8, 1922.

Digitalin
Digitalein
Digitsaponin)
Vegetable purgatives
Emodin
Chrysophanic acid
Resins

3. Definite chemical entities the details of the structure of which are incompletely known:
Morphine
Quinine
Strychnine
Eserine
Thyroxin

4. Substances of definitely known structural formula:
Simpler compounds
Inorganic
Organic
Natural alkaloids
Animal
Vegetable
Synthetics
Barbitone
Novocaine
Salicylates
Atophan
Phenacetine
Chloramines
Acriflavine
Atoxyl
Salvarsan
"Bayer 205"

In every one of these groups the synthetic chemist should find attractive problems. In the first three these relate evidently to the promotion of the substances to a higher category, especially the fourth. But once a drug has attained the final group the chances are still overwhelmingly against being ideally suited to its purpose, and so the synthetic chemist must consider converting it into something a little different but more perfect. This means cooperation between chemistry and pharmacology.

To better illustrate the nature of the problems involved a number of substances from each of the four classes may be discussed. The first category includes three of animal origin. They are known as "endocrine" substances or "internal secretions" because they are elaborated by some organ of the body, and poured directly into the blood stream. Excess or deficit of endocrine principles means disease. In the latter instance the supply may often be satisfactorily maintained by administration of the required active principle.

The first drug which I have noted is the secretion of a part of the pituitary gland (attached to the center of the lower surface of the brain) which has the power of causing contractions in the muscular walls of many so-called involuntary organs. It is used particularly in obstetrical work for its effect in stimulating contractions of the uterus. A well-known chemical substance exhibiting similar pharmacological characters is histamine, but Abel has recently prepared an extract of the pituitary exhibiting twenty times the strength of histamine.

Insulin is the term applied by Banting, Best and Macleod, of Toronto, to their new pancreatic extract which is unquestionably able to lower the blood sugar content of both normal and diabetic organisms, regardless of how high a place it may ultimately take among the remedies for diabetes. The chemist who first succeeds in identifying the active substance in this preparation will have made a contribution of great value to pharmacology.

Secretin is an extract of the duodenal mucosa which, as Bayliss and Starling show, is normally absorbed into the blood stream and carried to the pancreas, where it stimulates the digestive function of that organ.

Antivenoms and antitoxins present difficulties to the chemist on account of the comparatively small quantities available. Profound effects in the body result from the introduction of solutions which contain but fractions of a milligram of pure principle.

Of the second class of drugs—those yielding unsatisfactory chemical principles, the most important members are the digitalis bodies and some of the vegetable purgatives. Of the former the alcohol-soluble crystalline *digitoxin* exhibits the required therapeutic properties, that is to say strengthening and regularizing the action of the diseased heart, but in its pure form presents undesirable side actions, so that the Galenical preparations, which are of course impure mixtures, are found much more efficient in safe doses.

From the vegetable purgatives such as cascara and rhubarb have been isolated emodin and chrysophanic acid—derivatives of anthraquinone. Other vegetable purgatives contain

definite resinous principles, but here again the crude drugs are preferred, as they delay absorption of these purgative principles from the bowel into the blood stream, and thus prolong their action in the former region where it is desired.

In the third class have lingered for about one hundred years a number of the most important alkaloids. The chemical isolation of these early in the nineteenth century is associated particularly with the names of Pelletier and Sertuerner.

Morphine, quinine, strychnine, eserine and others still defy the structural chemists; witness, for example, the conflicting views of Knorr and Pschorr concerning the first of these alkaloids.

Thyroxin is the second of the endocrine principles to have been isolated chemically; this was brilliantly accomplished in recent years by Kendall. The assigned structural formula has however not yet been substantiated, but the drug appears to be a trihydro, tri-iodo derivative of indol propionic acid. It has a content of about sixty-five per cent. iodine, which element has long been recognized as essential to the action of the thyroid principle, although of itself unavailing. Crude thyroid extract has for thirty years occupied a most prominent place in therapeutics. Its constant use keeps in a normal condition those who are unfortunate enough to exhibit a deficiency in the function of this gland.

The large fourth class contains, of course, all the simpler inorganic and organic drugs. Acids, bases and even elements are used in therapy, as well as ether, chloroform, phenol and numerous other organic chemicals. It is surprising how many of these present new chemical problems for the pharmacologist. Attempts, for example, have been made to prove that certain of the metals should preferably be introduced in the colloidal state. At the present time one hears reports of the possibility of colloidal lead as a cancer cure. Again, pure ether has been called into question in recent years. The so-called "Cotton process" ether has been widely advertised as containing impurities to which the anesthetic effects are really due. Chemically pure ethoxy-ethane, however, has been vindicated within the last year by Drs. Stehle and Bourne both clinically and in our laboratory.

SYNTHETIC DRUGS

The natural alkaloids.—Many of the natural alkaloids can now be imitated synthetically, for example, atropine and cocaine, and among the animal alkaloids, the first endocrine drug to be isolated, adrenaline or epinephrine, a powerful circulatory stimulant and hemostatic. Improvements over the first two alkaloids named are seen in the synthetics homatropine and procaine (novocaine) respectively. Procaine in turn is being replaced for some anesthetic purposes by Hirschfelder's saligenin, an instance of an old chemical adapted to a new use.

Countless other synthetic drugs have been developed. Among the most useful of these are barbitone of the hypnotics, acetyl salicylic-acid (aspirin) of the anti-rheumatics, atophan and phenacetine which resemble aspirin in so far as they possess antipyretic and analgesic properties. Such antiseptics as the chloramines and flavines and such agents as atoxyl and salvarsan suggest most interesting chapters in so-called chemotherapy.[2]

Among the newest of synthetics is "Bayer 205" now widely quoted as having been described in Hamburg as the "key to colonial possessions." Its significance lies in its curative value in tropical "sleeping sickness," in which it is said to exhibit the unusual therapeutic ratio of curative dose to toxic dose of 1 to 60.

The chemistry of pharmacological agents concerns itself further with their fate in the body. Nature's laboratory can transform them in many ways. Oxidations, reductions, decompositions and syntheses of drugs all occur, and the resulting products exhibit sometimes less and sometimes more pharmacological activity than the original substance. Thus the conversion to something else in the body may be essential to bring out the real action of a drug, or the result of the change may be to detoxify, as for example, when an excess of morphine is oxidized in the body.

The second of the three suggested fields of pharmacology embraces the living things upon which the drugs and poisons act. The behavior of living organisms considered apart from drugs pertains especially to the realms of physiology

[2] By usage the term "chemotherapy" is generally restricted to the employment of specific etiotropic agents.

and pathology. The chemical viewpoint is continually assuming larger proportions in these fields, and the pharmacologist is continually concerned with their problems.

PHARMACOLOGICAL REACTIONS

Let us pass, however, to our third division which constitutes pharmacology in its restricted sense, and discuss the reactions between chemical agents and living things. *What* are these pharmacological reactions, and *why* do they occur?

To answer the first question one measures the various manifestations of drug action by either chemical, physical or psychological methods. By chemical methods we may determine changes in the carbon dioxide output of the lungs, in the alkali reserve of the blood, or detect the presence of abnormal constituents in the urine, such as sugar or albumen; any of these things may be influenced by drugs. Examples of physical manifestations are seen in changes in the blood pressure, the pulse rate, the size of the pupil, the temperature of the body, and many others. More difficult of exact measurement are those pharmacological actions which are only subjectively appreciated. The psychical effects of caffein, for example, must be tested by the study of the abilities of perception, association, etc. Still more difficult is it to measure the relief of pain, and to decide in which cases this is really due to the action of the drug.

Although to demonstrate the existence of many pharmacological reactions we do not always need to invoke the aid of chemistry, this does become necessary when one approaches the more fundamental question of *why*. The rate and output of the heart are, for example, measured in physical units, but their ultimate basis is chemical or physico-chemical, as are the reactions between drug and cell which may alter them. In the study of these reactions comparatively little progress has been made. One fact, however, concerning changes in function produced by drugs appears to be certain, —they are never qualitative. While we may increase or decrease a cell's normal activity we can not alter its nature. By, however, stimulating certain functions, depressing others coincidently, and leaving still others untouched, drugs and poisons can elicit an endless variety of responses, as seen, for example, in the different types of behavior produced by various convulsants or by narcotics.

In seeking to determine why certain effects are produced by chemical substances, cells and tissues may be removed from the body and investigated while thus isolated, but such methods lead to wrong inferences as to the nature of the reaction *in vivo* unless many of the changed conditions are taken into consideration. Not the least important factor is the rôle of the medium in which the pharmacological agent is dissolved. What happens in an aqueous solution may be very different from the result in the presence of a complex of colloids, salts, etc., such as the blood. One of the chief foundations of pharmacology, therefore, is the chemistry of the blood.

Among the factors concerned in the reaction between drug and cell must be considered changes in osmotic conditions, surface tension, cell permeability, absorption, hydrogen-ion concentration and the like. The mechanism of narcotic action is partially elucidated in many cases by reference to the interesting parallelism between the lipoid-solubility and narcotic effects of a series of anesthetic drugs. But because the cells of the nervous system owing to their lipoid content exhibit an affinity for such drugs, does not tell us why the satisfaction of this affinity should necessarily alter their function. One may conceive of the molecule of chloroform, for instance, binding itself to certain constituents of the cell which normally function by a continual give and take of other substances. When this occurs function would become depressed or cease; but direct evidence in support of this and similar explanations is lacking.

As another example of pharmacological analysis, take the effects of certain poisons upon the heart. Straub has shown that while one of these will act only when a certain amount has penetrated into the interior of the cell, another merely requires contact with the cell surface. The latter appears to enter into no sort of reaction, for it can be recovered practically quantitatively from the fluid leaving the heart. A third poison exhibits its action only while passing in or out of the cell, that is to say, during the period in which chemical equilibrium is being established between the cell and the medium which surrounds it. Again we are at

a loss for definite knowledge of the nature of the reaction between drug and cell.

A few cases seem simpler and are perhaps better understood, among which may be mentioned the combination of pharmacological agents with the hemoglobin of the red blood cell. Ordinarily the hemoglobin carries oxygen in loose combination. When a toxic substance, for example, carbon monoxide, which has a greater affinity for hemoglobin, enters the blood, there is formed the firmer combination known as carbon monoxide-hemoglobin. Oxygen transportation is thus interfered with to an extent which may or may not be compatible with the continuation of life. This will depend upon the percentage of carbon monoxide in the inspired air, and the consequent concentration in the blood. The minimal lethal concentration is, of course, less in rarefied atmospheres where there is less oxygen with which the poisonous gas has to compete.

ANTIPYRETIC DRUGS

The variety in the nature of the chemical bearings of pharmacology may be illustrated further by examples from a single field, that of the action of antipyretic drugs. The term "antipyretic action" was introduced to describe the reduction of fever temperature, but drugs having this capacity, of which we have mentioned the salicylates, atophan and phenacetine, all exhibit to a greater or less extent the property of relieving pain. This analgesic action constitutes their widest field of usefulness today.

To the need of improvement upon most, if not all, of our present synthetics reference has already been made. Among the antipyretics salicylates and atophan in their use in rheumatic fever require doses which sometimes approach the point of toxicity. The ethyl ester of methyl atophan, known as tolysin, appears to remove this objection, for we have found that it is far less toxic. Dr. Lozinsky and I have shown in experiments on dogs as well as in human rheumatic fever that the reason for the comparative safety of this drug is its slow rate of absorption from the intestine. Given over a considerable period of time it is just as efficient as salicylates, and is completely absorbed in therapeutic doses, but when larger amounts are introduced the excess above the therapeutic dose can be largely recovered chemically in the excreta, never having been absorbed by the body at all. This coincidence of therapeutic dosage with the limits of intestinal absorption is a fortunate peculiarity in pharmacological action.

The structure of tolysin is based on the so-called salol principle, the esterification protecting the stomach from the irritating action of carboxylic acid. The dog's stomach is unharmed by doses the aspirin equivalent of which produces serious erosion and ulceration.

FEVER

The mechanism of antipyretic drug action involves a number of problems in our second group. The behavior of living things includes an understanding of the physiology of temperature regulation and the pathology of fever. What are the chemical and other differences between the fevered and the normal organism?

In fever there is an increase in the production of bodily heat; this is paralleled by an increase in the oxidations which, in fact, are usually taken as a measure of the heat production in the body. Increased heat production is not, however, the cause of fever, for far greater increases fail to raise the temperature of a healthy subject. DuBois has recently shown in a variety of clinical fevers that the increase of bodily oxidations corresponds quantitatively to Van't Hoff's law that the velocity of chemical processes increases from two to three times for every 10°C. increase in temperature. The poisons which produce human fevers, whether of bacteriological origin or chemically known substances such as cocaine, do not then accomplish this by increasing the production of heat, but rather by interfering with the mechanism by which heat is eliminated from the body.

This heat-dissipating mechanism has hitherto been considered to depend chiefly upon the shifting of blood from the protected regions of the body to the surface. But in the reaction against a hot environment the blood becomes not merely shifted but diluted, thus affording both a larger surface flow for radiation and more "free" water for evaporation from the lungs and for sweating.

Now in the production of fever these heat-dissipating processes become disturbed, and we are all familiar with the blanching of the skin

due to peripheral vaso-constriction, and the chilly feeling which accompanies a sharp rise in body temperature. These indications of a poor surface flow are associated with a loss of water from the blood, as I have shown particularly in the case of "coli fever" with Dr. Howard, and of cocaine fever with Dr. Moise. The loss of water from the blood may be variously measured, for instance by colorimetric determination of the hemoglobin content, by red blood cell counts, or by weighing blood samples before and after drying to determine the total solids. Certain poorly diffusible dyes may also be injected for the purpose of measuring changes in the water content of the blood. Among other accompaniments of water loss is noted increased blood viscosity.

A further change in the chemistry of the blood in experimental fever has recently been noted by Sansum, who found that the alkali reserve or titration alkalinity of the blood becomes diminished as the temperature rises. One is therefore bound to speculate upon the possibility of water shifting being influenced by the formation of acids in the tissues in connection with the "chill" phenomenon. This and questions relating to the permeability of the cells, and to the rôle of other physical or chemical changes produced by fever poisons afford an untilled field for investigation.

MECHANISM OF ANTIPYRETIC ACTION

To return to the action of antipyretic drugs in fever—this has been investigated both from the point of view of the effects of these drugs upon heat production, and upon heat dissipation. In numerous tests upon fever patients I have found that drug antipyresis is accompanied by only a slight decrease in heat production. The decrease corresponds to the demands of Van't Hoff's law and seems therefore an effect rather than a cause of the temperature fall. Diminished heat production does not then suffice to account for the phenomenon.

Elimination of heat on the other hand was found greatly increased, for example, in the case of aspirin antipyresis. In my experiments the elimination of heat was increased by nearly 40 per cent., its production reduced by less than 4 per cent. The process of dissipation, therefore, is the one which is most affected, and this mechanism is approached, as said, through studies of the circulation.

Nearly every one has witnessed the reddening of the skin and sweating which is associated with antipyretic action, and in this connection Dr. Herrmann and I first showed that antipyretic drugs dilute the blood of the fevered animal coincidently with the reduction in temperature. Evidence of the importance of this increase in the water content of the blood is found in the fact that in healthy subjects equivalent doses of antipyretics will neither reduce the temperature nor dilute the blood.

Having observed some increase in the dextrose content of the blood as a result of antipyretic drug action, and having noted also that dextrose itself may reduce the body temperature, we were led to consider an increase in the osmotic pressure of the blood as possibly responsible for the accumulation of water. This argument was pursued by the injection of dextrose intravenously in normal and in fevered animals. It was found that under the same conditions in which dextrose produced a slight dilution of the blood and no fall in temperature of the normal animal, a marked antipyretic action with rapid and extensive dilution of the blood was seen in the case of fever. Similarly, intravenous injections of acacia were found to reduce the temperature of fevered rabbits and dogs. The question of antipyretic drug action therefore resolves itself into a problem with many chemical bearings, especially that of water shifting and water metabolism in the body.

Before leaving the antipyretic drugs attention may be called to studies which Dr. D. S. Lewis and I made of the mechanism of their analgesic action. Coincident with the relief of headache we have found again a dilution of the blood, which, as stated above, does not occur in normal individuals. Since Cushing, Weed and others have shown that so-called pressure headaches may be relieved by use of concentrated salt solutions, either by mouth or intravenously, apparently withdrawing fluid from the brain in this way, one is led to expect that antipyretic drugs may act in a similar manner.

Sufficient has been said to indicate how superficial our knowledge of drug action still is,

and in how many directions the aid of chemistry must be invoked.

HENRY G. BARBOUR
McGILL UNIVERSITY

THE PRESENT SITUATION IN THE RADIUM INDUSTRY[1]

DISCOVERY OF RADIUM

THE discovery of X-ray in 1895 by Roentgen paved the way for the discovery of radioactivity which occurred about a year later. Becquerel, stimulated by the observations of Roentgen, investigated the field of phosphorescent light and found that phosphorescent uranium compounds emitted a type of radiation similar to X-ray in that it traversed material bodies.

This property of uranium salts was later found to be due to the disintegration of the uranium atom and not to phosphorescent light, and this eventually led to the discovery of the entire uranium series consisting of fifteen radioactive elements.

UNITED STATES THE PRINCIPAL PRODUCER IN THE PAST

Although radium has been found in many countries of the world, including Bohemia, Portugal, Australia and England, the United States has been the principal producer.

It has been estimated that 150 grams of radium, costing approximately $20,000,000, have gone into consumption to date in the United States, of which 90 per cent. has come from the carnotite ores of southwestern Colorado and southeastern Utah, which clearly shows the commanding position the American industry has enjoyed. This industry is naturally exceedingly young, not having existed more than fifteen years. During this time about ten domestic companies have engaged in the production and sale of radium. Last year five companies were still operating.

In spite of the youth of the industry, approximately $10,000,000 have been expended by American companies, this capital being entirely represented by mines and plants.

[1] A paper given before a joint meeting of the American Chemical Society, the American Electrochemical Society and the Société de Chimie Industrielle, New York Sections, February 9, 1923.

PROBLEMS OF AMERICAN PRODUCER

American carnotite ore is low grade, running about 2 per cent. uranium oxide content. The deposits, although extensive, are spotty and must be prospected by means of the diamond drill. It is true that the ore occurs near the surface, but after it is mined it has to be hand-sorted, put in canvas bags, packed several miles by mules to a motor truck line, hauled by motor truck to a narrow gauge railroad line, transferred from narrow to standard gauge and transported to Denver. The cost per ton varies between $40 to $70 depending on the location of the ore and on 2 per cent. ore; this means that 98 per cent. of these high freight rates is paid on sandstone.

As ore bodies are widely scattered, and as one pound of acid is required to treat each pound of ore, it would not be profitable either to treat the ore at the mines or to put up a mill for water concentration.

Besides the physical difficulties of prospecting and of transporting the ore to the plant, exceedingly complicated chemical problems are met with in the treatment of the ore, 200 to 400 tons having to be treated to produce one gram of radium. This can be understood when it is remembered that radium is a disintegration product of uranium, there being only one part of radium to 3,200,000 parts of uranium in any ore.

Never a year went by but rumors were circulated of the discovery of rich deposits of radium-bearing ore which would put the American producer out of business and these rumors had to be carefully investigated at heavy expense.

RADIUM IN THE BELGIAN CONGO

Strange to say, during all this time deposits of radium bearing ores, many times as rich as the American carnotite ore, existed in the Belgian Congo.

These ores were discovered in 1913 near Elizabethville in the province of Katanga, in the course of prospecting work which was being done on the Luiswishi copper owned by the Union Miniere de Haut Katanga, a powerful Belgian corporation.

Shortly after the discovery and before any commercial operation of the deposits could be attempted, the war broke out and the Union

Miniere found its technical and commercial staff depleted. In addition, it was forced to increase its output of copper to 40,000 tons per year for use by the allied countries and these conditions temporarily prohibited the exploration and development of the radium properties.

It must also be remembered that the outcome of the war could not be accurately predicted; hence the Belgians endeavored to keep their discoveries secret, thinking that should the war be lost they might still control the output of radium.

After the war, the company recruited its staff and commenced development. The policy of secrecy was still maintained, however, and no announcement was published until the largest plant in the world for treatment of radium ore had been completed at Oolen, Belgium, and the Belgian company was in readiness to start production.

RESULT OF BELGIAN COMPETITION

The announcement of the Belgians was received by American producers with considerable concern; hence when the Belgians invited two of the large American companies to confer, they were quick to send their representatives to Belgium.

It was immediately recognized that the African deposits must be of considerable size to warrant the erection of the Oolen plant, in spite of the fact that this plant could be used for other purposes than the treatment of radium ores.

While it is true that the Belgians must transport their ore 2,000 miles down the Congo River, across the ocean to Antwerp and thence by rail to Oolen, this procedure is much more economical than endeavoring to treat the ore in the heart of Africa, and notwithstanding this long haul, Belgian radium can undersell the American product by a large margin.

The conference between the representatives of the American companies and the Belgians resulted in The Radium Company of Colorado forming a joint selling organization with the Belgians, and the new company will market radium throughout the world.

With the appearance on the market of the Belgian product, the American mines shut down and the price of radium dropped to $70 per milligram, the lowest price on record.

The question of a tariff to protect the American radium industry naturally occurred to the American producers and although the difficulty of obtaining protection was realized, the moral issue at stake was really the factor which decided against action in this connection. The world needs radium to combat cancer and it was recognized that the lower the price the more widespread would be the use of this valuable agent.

RADIUM PRESENTS DIFFICULT SALES PROBLEMS

The sale of radium is a most complicated problem. Radium therapy is a new science and the first essential is to bring home to the doctor the value of radium in the treatment of various conditions and for this purpose medical departments are maintained. These departments publish periodicals containing the latest articles on the therapeutic use of radium and act in a general consulting capacity to doctors using or contemplating the use of radium.

Once the doctor is convinced of the value of radium, the work is but half done. Radium is a dangerous agent and must be handled with great care. Hence the American companies were obliged to dot the country with post-graduate schools qualified to give adequate instruction to the purchasers.

Again there is the question of instruments for the therapeutic application of radium and the companies have had to maintain elaborate medical research departments to devise and manufacture the most efficient accessories possible. No doubt these departments do some of the most precise work being done to-day, although the volume of their output is comparatively limited.

Besides these special departments, the commercial companies have had to maintain elaborate chemical and physical departments and hence the Belgians have gained a large advantage by being able to draw on the accumulated technical and sales knowledge of their American associate. The net result of the consolidation will undoubtedly result in as cheap and probably cheaper radium than had the consolidation not taken place.

METHODS OF MANUFACTURE AND PRECAUTIONS REQUIRED

Just a brief sketch of the methods of producing radium from the American carnotite

ore and precautions required may be of interest.

The ore is crushed, the radium leached out and the solution treated with sulphuric acid to precipitate the insoluble radium barium sulphate. This precipitate is changed into the soluble carbonate and this resulting solution is converted into the bromide and that in turn into the chloride. Radium always occurs with barium and a physical property of the radium chloride is used to separate it from barium chloride as the former is less soluble in saturated solution than the latter. About 2,200 separate crystallizations are required to produce radium chloride of 95 per cent. purity.

Large fans are in constant operation over the vats containing the radium liquors. These serve to drive off the gaseous emanation and prevent it from breaking down and depositing in the immediate vicinity as radium a, b and c which are solids and which give off destructive rays.

There is no particular danger in handling radium sulphate freshly precipitated, as it does not start disintegrating to any appreciable extent for three or four days after precipitation. Therefore preparations of these salts can be made up with comparative safety.

Continued handling of radium preparations lowers the blood count and produces a general anemic condition. Because of this fact, the United States Bureau of Standards and the commercial companies take the blood count of their employees regularly. If the employee's health has become impaired, he is given a vacation, away from radium, to enable him to recuperate.

COMMERCIAL USES OF RADIUM

You will have gathered from some of the previous statements that one of the chief uses of radium is in the medical profession.

It was early discovered that radium broke down successively into radium emanation, radium a, radium b, radium c and radium d, gaining equilibrium with these decay products in approximately 30 days. During this process of disintegration, three rays are given off—alpha, beta and gamma. The first has little penetrating power and is stopped by a sheet of paper. The second is more penetrating, while some of the third will penetrate ten inches of steel. Shortly after the discovery of radium it was found that the last two rays were destructive to certain kinds of cells and the medical use of radium in the treatment of various conditions is built around this susceptibility of the cell to the action of radium rays.

Many different conditions are treated by radium, including cancers and tumors, although radium is also used in much less serious conditions; for example, the removal of birthmarks, warts and tonsils.

At present extensive work is being done on cancer. Except in very advanced cases, this disease can be arrested, but the big problem is to prevent its recurrence. In case it does not recur in ten years, it can be considered to have been cured. Ten years, however, is a very long time for experimental purposes, and interesting experiments are now being carried on with mice and flies. If the disease does not recur in ten weeks in the case of mice, it has been eradicated, while in the case of flies, the time can be measured in days. Hence these experiments will shortly give knowledge which would require an exceedingly long time to acquire by the treatment of human beings.

Two general methods are being followed today in the use of radium in medicine. The first is the use of radium sulphate put up in needles, tubes and plaques. The needles most widely used are the 10 milligram non-corrosive steel needle having a diameter of 1.5 millimeters and a length of 29 millimeters (about the width of a pin head and a trifle longer than the ordinary pin), and the 5 milligram needle having the same diameter with half the length. The barrel of these needles is bored out to provide a radium chamber into which the radium is inserted. Asbestos packing is then placed next to the radium, the eye is inserted and then soldered into place.

In the treatment of disease these needles are buried directly in the affected tissue and left until the required radiation has been delivered.

The tubes employed are made of glass, filled with radium, sealed, and are usually enclosed in small metal capsules which are placed against the tissue to be treated.

Plaques are flat surface applicators containing a fine layer of radium salt underneath a layer of non-corrosive steel, the latter being

usually about one tenth of a millimeter in thickness. This permits a large proportion of the hard beta rays to pass, these rays being beneficial in many skin conditions.

An adequate initial supply of radium for the individual doctor would be about 100 milligrams, costing around $7,500, including applicators which are now furnished without charge with the radium. As radium has a half life period of 1,760 years, this amount would decay to 50 milligrams in that time. Hence for all practical purposes it is everlasting.

Insurance rates on radium in the forms mentioned are relatively high, amounting to about 2½ per cent. per annum. These high rates are due to the chances of loss surrounding the use of the element as above mentioned.

A second method is the use of radium emanation which is the first disintegration product of radium and a gas. This necessitates the use of a solution of some radium salt, preferably the bromide, which is unstable. The radium solution is usually placed in a closed container in a safe with a tube leading to a pumping and collecting apparatus, the gas being pumped off and collected in fine glass capillary tubes. These are sealed off by flame and imbedded in the tissue-like needles except that needles are extracted while the glass spicules are left in. The radioactivity in these spicules loses 16.5 per cent. of its activity the first day, 16 per cent. of the balance the second day, and so on, becoming entirely inactive in 30 days.

The minimum quantity of radium necessary for this technique plus the cost of an emanation apparatus would run at to-day's prices in the neighborhood of $40,000. Insurance charges on the radium in this form are less than on needles, tubes and plaques, being about ½ per cent., but there is the added cost of keeping a trained physicist to collect and measure the emanation. However, this method, supplemented with needles and plaques, would be extensively used were it not for the large initial cost.

One of the properties of the radium rays is that they ionize a gas and this property is used in making measurements by means of the electroscope instead of using the weight measure which would be impractical with such minute quantities. Radium is usually sold on United States Bureau of Standards certificates as to amount of radioactivity present as determined by the electroscope, the radium companies guaranteeing the purity of the radium. Determination by the electroscope is exceedingly accurate and Soddy has stated that if half a grain of radium bromide were divided equally among every human being in the world, one such portion could be detected.

The second largest use of radioactive substances is in the manufacture of luminous material for a variety of uses, such as for watch dials, electric switches, pendants and novelties. Here again the rays emitted by radium are made use of. Zinc sulphide crystals when bombarded by radium rays become luminous and a compound of this substance and a radioactive element is mixed with varnish and applied to the area where the luminosity is desired. The life of these luminous substances is roughly from two to ten years, depending on the quantity of radioactive substance present. Zinc sulphide crystals break down under the constant bombardment, so the greater the luminosity the shorter the life.

The radium companies get out a spinthariscope for display purposes. This is a short metal cylinder about one inch high and half an inch in diameter. In the bottom is placed about one twentieth of a cent's worth of radium mixed with zinc sulphide crystals, and when this is viewed in the dark room through a lens at the top of the cylinder, a myriad of tiny flashes can be seen. Were it not for the destruction of the zinc sulphide crystals these flashes would continue for 2,500 years, which gives an idea of the size of the atom. Rutherford has calculated one gram of radium in equilibrium with its decay products emits 140,000 billion alpha particles per second.

THE FUTURE OF RADIUM

The future of radium in the medical and luminous material field is assured. As to other future uses it would be idle to speculate. Certainly its properties as a catalyzer and ionizer are worth careful investigation. Here is a substance combining infinitesimal bulk with maximum energy. Those who are engaged in the radium industry would not be surprised to see this substance in use in many commercial fields within the next few years. As a matter of fact, its ionizing properties are now being

tried out by several companies along commercial lines.

H. E. BISHOP

EASTERN MANAGER,
RADIUM COMPANY OF COLORADO

CHANGES IN LONGEVITY OF AMERICANS IN THE LAST DECADE

EVIDENCE was given by the writer in the issue of SCIENCE of July 7, 1916, in the form of abridged mortality tables to show that the average length of life has been increasing for the whole span of life for both sexes of the registration area of this country, at least ever since the federal government began to compile statistics which could be safely used in the construction of such tables. The same tables showed also, however, that this improvement in longevity was being realized in spite of a deterioration or retrogression at certain advanced ages and that the average length of life corresponding to those advanced ages was less in 1910 than it had been for at least twenty years. The record of the females seemed, however, to be a little more promising than that of the males because the retrogression of that sex was less pronounced in the decade from 1900 to 1910 than from 1890 to 1900 while in the case of the males it was a little more pronounced except that, as also in the case of the females, slight evidence appeared in the last decade of a "come back" at the extremely advanced ages.

The purpose of this paper is to extend the results of the paper just mentioned to include those of 1920. It will be noticed that the record of both sexes shows remarkable changes. Although the explanation of the method[1] of constructing abridged mortality tables and the mortality tables themselves are omitted here it should be said that whereas the populations were necessarily changed slightly during the earlier investigation in order to include the year 1890 this investigation includes only the years 1900, 1910 and 1920. The mortality tables then were constructed from the population and mortality statistics of each of the three years just mentioned for the ten registration states, Connecticut, Indiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Rhode Island and Vermont. Since the tables are constructed from the statistical data of single years and without any process of smoothing it is well to repeat the statement of the earlier paper that no claims are made in regard to the accuracy of the absolute results. Attention is called merely to the *trend* of the death rates and longevity. Moreover, it is obvious that the conclusions of this paper refer particularly to the populations of the states included in the investigation but should apply in a general way to populations of states of the same general geographical area. The abridged list of death rates and corresponding differences are as follows:

DEATH RATES PER 10,000

AGES	1900	DIFF.	1910	DIFF.	1920
		FEMALES			
10	39	— 9	30	— 4	26
20	58	—15	43	+ 3	46
30	83	—20	63	+ 6	69
40	98	—14	84	— 3	81
50	143	—11	132	—10	122
60	262	+ 2	264	—15	249
70	549	+20	569	— 1	568
80	1206	+44	1250	—25	1225
		MALES			
10	39	— 7	32	— 2	30
20	60	—12	48	— 3	45
30	83	—13	70	— 8	62
40	109	— 3	106	—23	83
50	159	+ 8	167	—35	132
60	293	+22	315	—34	281
70	606	+27	633	—29	604
80	1323	+45	1368	—36	1332

There is substantial agreement of the results of this paper and of the earlier paper cited above for the decades covered by both papers although it will be noticed on comparison that the ages considered are different. Thus, the death rates of females decreased for ages 50 and below but increased at the higher ages for the decade 1900 to 1910. In the decade from 1910 to 1920, however, two remarkable results are to be noticed. First, there is a substantial decrease in death rate at that period of advanced ages at which there has always been a retrogression. Second, an unexpected retrogression in the neighborhood of ages 20 to 30 is indicated. The latter is surprising because both males and females have never before in the previous twenty years failed to register a significant reduction in the death rate at all the earlier ages. It is especially surprising that this retrogression should occur among the females when we recall that the females al-

[1] October, 1919, Bulletin of the American Mathematical Society.

most always surpass the males in longevity and general health improvement. It is to be hoped that someone can offer an explanation of this retrogression.

The apparent sudden break in the differences in death rates at age 70 for this decade is a little disconcerting and is probably due to inaccuracy in the statistical data. When, however, we consider that the death rates given above are computed practically independent of each other it is more surprising perhaps that more "breaks" are not encountered.

The record of the males is also very unusual. Although the death rates decreased at ages 40 and below and increased at higher ages in the decade from 1900 to 1910, as was found in the earlier investigation, the death rates for the decade from 1910 to 1920 not only decreased at every age but decreased the most by far at the very ages at which there has always been a retrogression before; moreover, the decrease is much greater at those ages than in the case of the females. The improvement is so great at the advanced ages that the writer investigated the mortality statistics of 1919 and found them in substantial agreement. It should be stated parenthetically that since the population statistics are collected but once in a decade the mortality tables could be constructed only for the years considered without the employment of an undesirable scheme of interpolation for the population statistics.

The table of expectations of life is as follows:

EXPECTATIONS OF LIFE

AGES	1900	DIFF.	1910	DIFF.	1920
			FEMALES		
10	50.8	+1.9	52.7	+ .2	52.9
20	43.0	+1.5	44.5	+ .1	44.6
30	35.7	+ .8	36.5	+ .4	36.9
40	28.6	+ .3	28.9	+ .4	29.3
50	21.5	0	21.5	+ .3	21.8
60	15.0	— .2	14.8	+ .1	14.9
70	9.6	— .2	9.4	+ .1	9.5
80	5.6	— .1	5.5	0	5.5
			MALES		
10	49.7	+ .7	50.4	+1.9	52.3
20	41.8	+ .4	42.2	+1.8	44.0
30	34.5	— .1	34.4	+1.7	36.1
40	27.5	— .5	27.0	+1.4	28.4
50	20.6	— .5	20.1	+ .9	21.0
60	14.2	— .3	13.9	+ .4	14.3
70	9.0	— .1	8.9	+ .1	9.0
80	5.2	0	5.2	0	5.2

The values of the expectations of life afford little further information and serve mainly to show the total effect of changes in death rates at certain ages upon the prospect of earlier ages. Thus, although both sexes show an increase in the expectation of life at earlier ages and a decrease at the advanced ages with the females far in the advance as to general improvement in the decade from 1900 to 1910 the order in improvement is completely changed in the decade from 1910 to 1920. The males increase their expectation of life by almost two years at age 10 and since the expectation of life is approximately the same in all mortality tables at the age of birth and age 10 we have here a good estimate in the increase in the whole span of life. The increase in the expectation of life at the successive ages is also very substantial. In the case of the females there is an increase in the expectation of life at all ages but the increase is almost negligible. It is important, however, that there is no period of retrogression at all and it is evident that the increase would have been really significant if it had not been for the unexpected and unusual retrogression in death rates in the neighborhood of ages 20 and 30.

The writer gladly passes on to others the problem of explaining the great improvement at the advanced ages for both males and females or the "set back" at the earlier ages of the females in the last decade. Some claim that an unusually large number of the physically unfit (tubercular, etc.) was eliminated during the period of the war and this might well explain the improvement at the advanced ages. It would be interesting to know how much credit is due to agencies—like the Life Extension Institute, the Y. M. C. A., etc.—which are definitely devoted to the task of improving the health of the mature individual. Some will give much credit to prohibition and there may be considerable justification but it should be recalled in that connection that the last amendment did not go into anything like complete effect until some time after the first of the year (1920) whose mortality statistics form the basis of the results we are just considering.

C. H. FORSYTH
DARTMOUTH COLLEGE

THE OKLAHOMA-TEXAS BOUNDARY SUIT

THE Oklahoma-Texas boundary suit, in which a decision has recently been rendered by the Supreme Court of the United States, was of more than ordinary interest by reason of the large property values involved, the considerable

cost of the litigation, and the extent to which scientific investigations were utilized. The value of the property, particularly the small part of it known to be oil bearing, can be estimated only in millions of dollars. The testimony in this case as submitted to the Supreme Court, exclusive of the attorney's briefs and arguments, amounted to more than five thousand printed pages. This testimony was accompanied by about five hundred photographs and more than one hundred original maps and charts, prepared especially for this case. The cost of printing the testimony exclusive of maps and engravings was in excess of twenty-five thousand dollars. The total cost of the suit to the litigants probably exceeded one half million dollars.

In its historic setting, this case dates back to a treaty made between this country and Spain, in 1821, approximately one hundred years ago, which was intended to define the boundary line between the United States and the Spanish possessions. The boundary established by this treaty, reaffirmed by succeeding governments, ultimately became the boundary on the Red River between the States of Oklahoma and Texas. The exact place of this boundary line on the river having been called into question, suit was brought in 1919 by the State of Oklahoma against Texas to which the United States became intervener. The evidence presented consists of scientific and lay testimony. Geologic and ecologic investigations for the United States and Oklahoma were made by L. C. Glenn, Isaiah Bowman, H. C. Cowles and L. L. Janes, and for the State of Texas by E. H. Sellards, R. T. Hill and B. C. Tharp. The topographic surveys and maps incident and necessary to these investigations were made for Texas under direction of Arthur A. Stiles, state reclamation engineer, and for the United States under direction of Robert Livingston. After testimony as to soil conditions had been presented by Texas, certain members of the United States Bureau of soils were called into the case by the United States, including H. H. Bennett and others. Chemical analyses incidental to Texas investigations were made under the direction of E. P. Schoch. In all a total of twenty-eight men appeared in this suit as expert and scientific witnesses.[1]

A previous decision of the Supreme Court rendered in 1921, following an earlier decision made in 1896, placed the boundary between Texas and Oklahoma as on the south bank of the river. However, it remained to be determined what constituted the south bank of the river, where on that bank the boundary line should be drawn, and in what way, and to what extent the river had changed its course in the one hundred years since the treaty was made.

Much of the scientific testimony was concerned with the habits of the river, particularly in building its valley lands. Witnesses for the United States and Oklahoma concluded from their investigations that the valley land in the upper part of the river with a few exceptions was not in existence in its present form one hundred years ago when this treaty was made. It was also held by these scientists that the method of building this valley land in the upper Red River is by a process called "island building" and not by the more common processes known on other rivers. According to this theory the valley land is built up through the formation of a succession of islands, followed by the abrupt transfer of the water of the river around such islands, this process being described by them as avulsion. The reworking and rebuilding of the valley lands by this method is assumed by these scientists or some of them to have progressed at such rate as to have completely reworked and rebuilt all valleys in the upper reaches of the river, with few exceptions, within the past one hundred years.

The force of these contentions will be appreciated when it is remembered that it is a well established principle of law recognized by both parties to this suit that when a river forming a boundary line changes its course by the usual process known as erosion and accretion, that is, by the more or less gradual washing of the banks at one place and the deposi-

[1] The evidence in full in this case appears in the records of the Supreme Court of the United States, No. 23 original, 1920, and No. 20 original, October, 1921, Volumes I to IX, 5,513 pages.

tion of the washed material at another, the boundary line continues to follow the river and changes with it. On the other hand when a river owing to either natural or artificial causes abruptly leaves its channel and makes for itself a new channel the intervening land between the old and new channel remaining undisturbed, as in the case of ox-bow cut-offs, a change known as avulsion, the boundary line in such instances does not go with the river to its new channel but continues to follow the former channel. The theories advanced, if sustained, would have resulted in placing the state boundary line at or near the foot of the Texas bluff, thus throwing practically all of the river valley land of the upper part of the river into the State of Oklahoma. That is, under this interpretation Texas constantly loses by the shifting of the river, but never gains by deposition of sediments, the rate of loss progressing with such rapidity that practically the whole of the valley land in the upper stretches of this river has been lost to Texas within an interval of one century.

The investigations centered on, but were not confined to one particular valley in Wichita County known locally as the Big Bend into which the oil fields extend. Scientists representing the United States and Oklahoma maintained that one hundred years ago when this treaty was made, this valley, or such parts of it as may then have been in existence, was separated from the mainland by a channel of the river flowing at or near the Texas bluff. Trees in this valley in excess of one hundred years of age were said by the ecologists representing the United States to have had their inception on islands. These contentions, if sustained, would have placed this, as well as other Texas valleys, in the State of Oklahoma.

The State of Texas on the other hand maintained that neither the Red River channel, nor the sand stretch which borders the channel, nor any part of the channel or sand stretch lay adjacent to the Texas bluff in the Big Bend Area so recently as within the past one hundred years. With regard to changes in the course of the river, it was contended that in this river, as in other rivers, the change throughout the entire course of the river occurs in some instances by erosion and accretion and in some instances by avulsion, and that normally in this river where the land is being built up, as has been done in the past ages in the Big Bend Area, the change of the course of the river is by erosion and accretion. The larger valleys are regarded as in general exceeding one hundred years in age, at least in their older lands. Around the original nucleus of the valleys, in most instances, newer lands have been added from time to time, the controlling building process being by accretion. Ecologic studies indicate that the older portions of the Big Bend and other larger valleys have reached the climax stage of plant development, in this respect agreeing with the adjacent terraces and uplands. Under this interpretation the valley lands on the south side of the river belong wholly to the State of Texas throughout the entire course of the river where it forms the boundary.

The evidence presented in this suit may be classed as: (1) Physiographic, including discussion of the physical features of the valleys, such as sand dunes, their age and habits of building and shifting, sand bars, back valley streams, marginal fans, old stream channels and inter-dune depressions; (2) geologic, including discussion of sedimentation of river valleys in general, and such evidence as was available from fossils, particularly the more or less well mineralized bones of the buffalo and other animals formerly living in the valleys; (3) agrogeologic, including thickness, method of accumulation, age indications, alteration and succession of soils; and (4) ecologic, including relation of the vegetation of the valleys to that of the upland, as well as the age indication of the timber, shrubs and herbaceous vegetation of the valleys.

By the decision of the Supreme Court, now rendered, Texas retains the valley land up to the margin of the sand bed of the river, throughout the entire territory under controversy. In addition to the valley lands, counsel for Texas maintained that rights inherent in the treaty gave Texas possession to the waters edge, thus in places crossing more or less of the sand stretch which borders the river channel. This last named contention was not sustained in the majority opinion of the court although it is sustained in the dissenting opinion of Justice Mc. Reynolds.

The conclusions of the judges of the Supreme

Court based on the evidence relating to the age of the valley and the methods of building the valley land is indicated in the following extracts from the decision rendered.

EXTRACTS FROM THE DECISION OF THE SUPREME COURT OF THE UNITED STATES IN THE CASE OF OKLAHOMA VS. TEXAS, UNITED STATES INTERVENER. PP. 12-14.

Common experience suggests that there probably have been changes in this stretch of the Red River since 1821, but they cannot be merely conjectured. The party asserting material changes should carry the burden of proving them, whether they be recent or old. Some changes are shown here and conceded. Others are asserted on one side and denied on the other. A controverted one is ascribed to the so-called Big Bend Area, which is within the oil field. That area is now on the south side of the river and connected with the bluffs on that side. Oklahoma and the United States assert that in 1821 a channel of the river ran between it and the bluffs and that the river has since abandoned that channel. Texas denies this and insists that the situation in 1821 was practically as now. . . . It (the testimony of the experts) is so voluminous that it does not admit of extended statement or discussion here. We can only refer to important features and give our conclusions.

It (the Big Bend) is larger now than sixty years ago, but how much is uncertain. The enlargement is the result of intervening accretions. The habit of the river is to erode the outer bank of a bend and to accrete to the opposite bank. . . . On the outer part are physical evidences of the formation being comparatively recent. On the inner part are like evidences of the formation being old, among them being the presence of living trees more than a century old. One of the trees, a pecan, attained an age of 170 years. . . . To overcome the inference arising from the presence of the old trees, which were well scattered, testimony was presented to show that in 1821 these trees were all on islands, which afterwards were consolidated amongst themselves and with the land on the south side. We think this testimony is essentially speculative and not a proper basis for judgment. In this area, as elsewhere in the valley, a succession of depressions is found at the foot of the bluffs, and some testimony was produced to show that in 1821 the river, or a part of it, flowed there. It may be that the river was there long ago, but the testimony that it was there in 1821 is far from convincing. . . . Our conclusion is that the claim that the river, or any part of it, ran south of this area in 1821 is not sustained. So the boundary follows the cut bank around the northerly limit of the area.

E. H. SELLARDS

BUREAU OF ECONOMIC GEOLOGY
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UNIVERSITY OF TEXAS

CHAUNCEY WILLIAM WAGGONER[1]

IT is fitting that the faculty of West Virginia University in general session assembled should pay appropriate tribute to the memory of Chauncey William Waggoner, head of the department of physics in the university, whose life and work have been so abruptly and tragically ended.

Professor Waggoner had leave of absence from the university for a year and was engaged in following up certain scientific investigations in the interest of a large industrial corporation. In pursuit of this work he was visiting Shreveport, Louisiana, where he met with the unfortunate accident that caused his death. He was thrown from a horse on October 24 and died on October 26.

Chauncey William Waggoner was born at Rock Bridge, Ohio, February 23, 1881. He was graduated from Ohio University at Athens, Ohio, with the degree of B. S., in 1904, and from Cornell University with the degree of A. M. in 1905. For five years he was student and instructor in Cornell University. He specialized in physics and won his doctorate in 1909. In the same year he was chosen professor of physics and head of the department of physics in West Virginia University and took up his work at once.

The thirteen years that followed were years of unusual growth and expansion in the university, especially in the departments of science, and Professor Waggoner, in sympathy with this development, reorganized the department of physics adequately to meet the growing demands upon it. He was always anxious that his department should be well equipped and able to do efficient work, and that the standards of science teaching and scientific research in the university should be uniformly high. Toward these ideals he worked with splendid enthusiasm.

[1] Resolutions adopted by the Faculty of West Virginia University.

As a member in active attendance on the meetings of numerous national scientific bodies, he kept himself in close touch with the advances made in physics and engineering. He brought to this university and to his state valuable information gleaned from such associations, and shared it with others. He was himself active in research. As a result of his activities he was personally known to many of the leading physicists and engineers of the entire country, a number of whom have written letters of regret upon his untimely death and of highest appreciation for his personal friendship and for his contributions to science. The high estimate of his practical knowledge is attested by the fact that he served as consulting engineer to several large industrial corporations.

Before the establishment of a department of weights and measures in his state he labored gratuitously and tirelessly to secure the enactment of adequate and just legislation to regulate the use of weights and measures in the state, and after the establishment of a department of weights and measures in 1915, he worked zealously, as assistant commissioner of weights and measures, to help make this department useful and effective. His compensation for this was the satisfaction of knowing that he was helping to increase the sum total of honesty and square dealing among his fellowmen.

During the participation of the United States in the great war, Dr. Waggoner was chairman of the research committee of the state council of defense. He was also active in researches with industrial corporations engaged in the manufacture of munitions. In the early months of the participation of the United States in the war, he supervised the work of a class of young men taking training in radio signaling, and later had charge of a large signal corps training unit at the university.

Dr. Waggoner was broad in his views and many-sided in his interests. Native ability and scientific training guided him to well-based judgments. While tolerant of others' views, he was constructive and convincing in the presentation of his own views. Alert to every phase of civic and spiritual betterment, he showed himself in daily practice a sympathetic colleague, a kindly neighbor and a dutiful citizen. For young people he had especial sympathy, and he was active in encouraging their interest in religious and community life as in the pursuit of scientific knowledge. He had unusual zeal and energy. Hence, he labored without stint to advance the interests of youth, church, community and state. He had a strong moral courage. He therefore supported frankly and firmly, though with becoming courtesy toward adversaries, every cause which he deemed worthy of his espousal. His power of initiative and analysis made him a weighty advocate or a strong opponent. In him we find exemplified the finer qualities of scholar, teacher, colleague, neighbor and citizen.

ROBERT A. ARMSTRONG,
E. H. VICKERS,
F. A. MOLBY

JANUARY 10, 1923

SCIENTIFIC EVENTS

ANIMAL PATHOLOGY AT THE UNIVERSITY OF CAMBRIDGE

As has been noted in SCIENCE the senate of the University of Cambridge has accepted the offer of the ministry of agriculture of a sum of £30,000 to found a professorship of animal pathology. The London *Times* states that the foundation of the professorship is the first step towards the creation of an institute for research on animal diseases. It has long been felt with increasing keenness that the losses from disease among live stock have been unnecessarily large; that, in fact, a considerable proportion of these losses might be prevented by an extension of scientific research. This applies not only to those scourges which are widely advertised by the government measures adopted for their suppression, but to other more or less obscure diseases of which the farmer is aware, but about which the general public is ignorant. The aggregate losses from animal diseases amount to millions of pounds every year.

The expressed opinions of the farming community are said to have played a considerable part in inducing the ministry to make the present offer to Cambridge. Farmers have felt for some time that they could not go on bearing silently the losses caused by disease without making a determined effort to call in the aid of scientific research. Losses by disease may or may not be preventable, but whatever

the possibilities in this direction, the need for research can not be denied.

The first duty of the professor when he is appointed will be to prepare his plans, and it is understood that the government departments concerned are prepared to consider favorably schemes involving a total expenditure on buildings, staff and upkeep of £100,000 in the next four years. After that period the financing of the institute will depend upon circumstances. The million pounds voted under the Corn Production Acts (Repeal) Act, 1921, will be exhausted, and in the present state of depression it is impossible to foretell what may happen. If, however, the professor of animal pathology and his colleagues make good, financial assistance will no doubt be forthcoming.

The site chosen for the new institute is appropriate. Its headquarters will be placed in an extension of the School of Agriculture, where the new professor will have for his colleagues, among others, Professor T. B. Wood, Professor R. H. Biffen, Dr. F. H. A. Marshall and Mr. K. J. J. Mackenzie, who will assist him in directing his work on sound agricultural lines. His windows will look into the new biochemical laboratory, which is being built for Professor F. G. Hopkins, the discoverer of vitamines: a few yards away is the Molteno Institute, where Professor G. H. F. Nuttall pursues his studies in parasitology; the university medical school is only just the other side of Downing Street. The necessary paddocks, stables and animal houses will be provided at the field laboratories, which are situated just outside the town.

THE STERLING CHEMISTRY LABORATORY OF YALE UNIVERSITY

ON April 4, 1923, Yale University will formally dedicate the Sterling Chemistry Laboratory, a $2,000,000 structure and the first building erected by Yale from the funds made available by the bequest of John W. Sterling. The date chosen for the dedication has a historical significance at Yale, since on April 4, 1804, Benjamin Silliman, the first professor of chemistry in Yale College, delivered his first lecture on this subject. The dedication of this building will be an international scientific event, since English, Scotch, French, Italian, Dutch and Canadian universities are to be represented by a delegate from each of these countries. It also will take place during the meeting of the American Chemical Society in New Haven, when two thousand or more American chemists will be in attendance.

The Sterling Chemistry Laboratory is said to be the finest material plant in the world for the teaching of chemistry and the prosecution of research work. Entering the building one comes into a spacious lobby or entrance hall, with walls of stone reaching up to a high arched roof. Thence through massive arches one passes into a large cross hallway, paved with stone and with fumed-oak beams supporting its ceiling. Along this hallway and opening into it are classrooms and offices. In the north of the hallway are storage and stock rooms, a delivery court, shops and the laboratory of industrial chemistry, reaching from the foundations of the building to its roof. In this enormous room are placed pieces of apparatus of factory size. With its two galleries, its traveling crane, its lines of shafting and maze of pipes, this appears indeed a chemical manufacturing plant.

Passing up an imposing stone stairway one comes to the main floor of the building. To the front and opening from a similar hallway extending for two hundred and fifty feet across the building are other classrooms and two large lecture halls. On the opposite side of the hall are the offices of the faculty members. Along the two sides of the building are two narrow halls opening into a multitude of small private laboratories. The outer walls of these are the outer walls of the building. On the west side of the building, the walls thrust out into a projection surmounted by a tower. Below is the great side entrance with iron gates and massive doors, through which heavy trucks may pass into the building. Above is the library, furnished in dark oak with comfortable chairs, ample desks and tables, and at one end a fireplace. About the walls are thousands of volumes of chemical text-books and bound journals.

The whole center of the building is a space approximately one hundred and eighty by two hundred and fifty feet which is devoted to teaching laboratories. With the exception of the industrial chemistry laboratory which goes through to the first floor, all of these labora-

tories are on a single level and all are covered with the saw-tooth roof peculiar to the modern factory. In the center of this section is the supply room, accessible by virtue of being at the intersection of two hallways and communicating by elevator with the large storage and stock rooms in the floor below. A feature of this part of the building is that none of the partitions which divide the teaching laboratories are "structural." This is essentially one enormous room under a single roof. The dividing walls are but the thickness of one brick and can be torn down and shifted if necessary without inconveniencing any other part of the laboratory This feature, together with the easy accessibility of the plumbing and wiring, gives the flexibility which is so necessary if any building of this sort is to be permanent.

THE CIRCULATION OF AGRICULTURAL NEWS

AT a recent staff meeting of the New York Agricultural Experiment Station at Geneva, Dr. R. W. Thatcher, director of the station, read a report on the station news service for 1922. Beginning with January of last year items of timely interest on the work of the experiment station have been sent at frequent intervals to newspapers and farm papers, with the result that the station activities have been brought to the attention of a much larger number of persons than would be possible in any other way.

According to the report, a total of 152 different news stories dealing with the work of the station were sent out during the year. By means of returns from clipping bureaus, the station authorities are able to check up on the use of these stories in the newspapers, although the clipping bureaus undoubtedly fail to see many of the items. A close check is also kept on the stories appearing in farm papers received and in this way and through the clipping bureaus some idea is obtained of how extensively the news material is used.

During the past year accounts of the station work appeared 3,559 times in different papers. Of this number more than 1,200 were in daily papers, while 1,867 were in weekly newspapers. Items appeared 206 times in farm papers and 283 times in the county farm bureau publications of this state. Papers as far north as Maine and Canada, as far west as the Pacific Coast, and as far south as Tennessee and Virginia made frequent use of the station news service. It is estimated by the station authorities that the papers carrying the station news material had a total circulation of more than 45,000,000, and it is certain that many papers of which there is no record carried the station news items. The station officials expressed a keen sense of appreciation of the generous amount of space devoted to station news in the various papers.

The news service was inaugurated at the time that the mailing lists were revised along subject matter lines and the bulletin editions greatly reduced. The bulletins are now sent only to those who have asked to receive station publications on certain subjects with the idea that such a system of distribution will insure the bulletins going to those who will make the best use of them. The news service supplements the bulletin publications and renders a valuable service in calling attention to the recent findings and developments of the work.

THE ENGINEERING SOCIETIES LIBRARY

THE United Engineering Societies maintain a large library in the Engineering Societies Building, 29 West Thirty-ninth Street, New York City. It contains about 117,000 volumes and 32,000 pamphlets. While these are not entirely indexed, in the last three years about 150,000 cards have been added to the catalog. There is now available 50,000 subjects presented to prospective readers in a systematic and logical relation. These subjects are handled in two different ways: The searcher who wishes to exhaust his field will find all entries arranged from the large group down to the most minute in one place. The casual reader who wants a minute subject has an alphabetic subject index available.

The attendance at the library during 1922 was 26,000 persons. Enquiries made by telephone and correspondence brought the total number of users of the library up to 34,000. The library added 3,353 books to its collection during the year. Service bureau orders, including searches, translations and photoprints, were sent to forty-six states and to the Argentine Republic, Australia, Belgium, Bermuda, British West Indies, Canada, Chile, Cuba,

	1916	1919	1920	1921	1922
Number of words	307,904	227,300	352,970	289,000	343,130
German	70.4%	40%	62%	68.4%	72.6%
French	25.3	42	20	23.4	10.3
Italian	1.7	4	4	1.8	6.4
Scandinavian	1.0	7	4	1.3	1.9
Portuguese	.97	....	....	....	....
English	.56	....	....	....	....
Spanish	.07	3	....	2.3	1.0
Dutch	....	4	....	....	1.2
Russian	....	....	10	....	3.0
Japanese	....	....	....	2.0	2.6

Haiti, India, Italy, Japan, Mesopotamia, Mexico, Norway, Rumania, Spain, Sweden, Switzerland and the United Kingdom.

The accompanying table gives the available data concerning the number of words translated during the past few years, showing the relative amounts of German and French translated before, during and after the war.

H. ANDREWS

COMMITTEE MEETING ON STANDARDIZATION OF STAINS

ON March 2 at the Chemists Club in New York City there was held a meeting of the Executive Committee of the Commission on Standardization of Biological Stains. The members of this committee are: H. J. Conn, Geneva; F. B. Mallory, Boston; L. W. Sharp, Ithaca; J. A. Ambler, Washington, D. C., and S. I. Kornhauser, Louisville, Ky. The meeting was also attended by C. H. Herty to represent the Synthetic Organic Chemical Manufacturers' Association, and by F. P. Garvan and W. F. Keohan to represent the Chemical Foundation.

At this committee meeting the very encouraging results of the work were reported. It was shown that already the stains available in America are in practically all cases as good and sometimes better than the best of the prewar stains. The most important fact brought out at this meeting was that while the pre-war stains were standardized only in an empirical way, by buying large batches without knowing the exact composition of the dye, they must now be standardized on the basis of pure chemicals.

The reason for this is because it is proving that in some cases the impurities present in the pre-war stains were very necessary. Sometimes these impurities were other dyes and sometimes supposedly inert materials like dextrin. In all such cases the task plainly before the commission is to find out what the impurity is which was responsible for the good staining qualities of the impure product. Then in the future the users of stains must demand that these impurities be present, not as impurities, but as intentionally added ingredients. When this has been done and the products are labeled and used accordingly, the American stains will become standardized in a true sense of the term.

Very shortly the commission will begin issuing certification of definite batches of stain that it has found satisfactory. These stains will be put on the market under a special label bearing the name of the commission. Users of stains must be on the lookout for products bearing this label. Buyers of stains should also be on the watch for spurious imitations of this label put out by unreliable concerns. Any statement of certification not bearing the name of the commission is a certification by the manufacturer or dealer himself, and therefore has no value. A cut of the commission label will appear in this journal as soon as it is ready for the use of the manufacturers of stains.

The Chemical Foundation has agreed to support the work of this commission financially.

H. J. CONN

THE SOLAR ECLIPSE OF SEPTEMBER 10

THE State Department transmits to the Smithsonian Institution a communication from Mr. Leighton Hope, consul in charge at Ensenada, Mexico, on the conditions at Ensenada with respect to the observation of the total solar eclipse of September 10, 1923. An abstract of the consul's report is as follows:

The town is on the west coast of Lower California. The eclipse is total at Ensenada at 2:02 p.m. Weather conditions there promise

to be excellent. The town may be reached from San Diego by auto stage line over a rough but passable route in about five hours. If reached by sea it would probably require a special vessel as the two Mexican lines carrying passengers and freight from San Francisco and Los Angeles have somewhat irregular schedules at intervals of something like two weeks. Various points of vantage along the path of totality can be reached from Ensenada by automobile or by burro pack train, but facilities for such transportation are extremely limited there so that transportation should be arranged for in advance, probably at San Diego.

Ensenada is a small village with no hotel, one or two small rooming houses and a few Chinese restaurants. Camping out, however, would be pleasant. Meat, fresh vegetables, fruit and melons can be had at that season at reasonable prices and in sufficient quantity. Other supplies should be imported. Servants, cooks and ordinary labor will be difficult to obtain on the ground.

The town of Tia Juana, Mexico, near San Diego, has an unsavory reputation and it is not unlikely that criminals from there might visit Ensenada at the time of the eclipse, so that each member of observation parties should have a passport or other documents showing his nationality, identity and the purpose for which he is in Ensenada. Local authorities express themselves as anxious to do everything possible for the comfort of the guests on this occasion.

Provision for admission of apparatus duty free would have to be effected through the national government at Mexico City.

C. G. ABBOT,
Assistant Secretary

AWARD TO PROFESSOR MICHELSON[1]

MR. POST-WHEELER, who is on the staff of the American Embassy, attended the annual general meeting of the Royal Astronomical Society on February 9 to receive the gold medal on behalf of Professor A. A. Michelson, who was unable to be present himself.

Professor Eddington gave a most illuminating address on the reasons of the award, explaining that the necessity for the great separation of the mirrors receiving the pencils of light from the stars was to give sufficient difference of length of path to enable the rays from the two extremities of a diameter of the star to be in opposite phase, so that the bright regions of the image from one extremity should fall on the dark regions of the other and so cause the fringes to vanish. It was mentioned that the method had been successfully applied to the measurement of the diameters of Jupiter's satellites, but the stars seem to have been considered hopeless, till recent physical work on the distribution of energy in the spectrum led to the conclusion that the red stars have such dull surfaces that the brighter ones must have appreciable discs in order to give so much light.

The actual figure had been calculated for Betelgeuse, and the observed diameter afterwards proved to be very close to it.

Some letters from Mr. Pease were read, in which he described the great practical difficulties that were incurred in applying the method of diffraction fringes, and the long-continued trials that were finally crowned with success. One of the earliest successes was the determination of the orbit of Capella. This gave, for the first time, a really accurate value of the mass and absolute magnitude of a giant star, which had already proved of use in the physical studies that were being made on these bodies.

A recent interesting development of the Betelgeuse measures was that the diameter came out different at different times, to an extent much beyond the probable errors of the measures. Attempts were being made to correlate these changes with the variable brightness and variable radial velocity of the star, but it will be necessary to carry on these measurements for some time before a definite conclusion could be reached.

Professor Eddington went on to point out that the famous Michelson-Morley experiment, for which the Copley medal of the Royal Society was awarded in 1907, though not specially contemplated in the present award, might be considered as coming within its terms; for the measures were made by interference methods, and the question whether the movement of the

[1] From *Nature*.

earth through the ether could be detected was one of the highest astronomical interest. He knew that their medallist was disappointed at the negative result, but the whole of the system of relativity had been founded upon it, so that in his (Professor Eddington's) opinion it was more fruitful than a positive result would have been.

In handing the medal to Mr. Post-Wheeler he asked him to transmit to Professor Michelson their congratulations on his success and their good wishes for the long continuance of his fruitful labors. Mr. Post-Wheeler replied in a few suitable words expressing his sense of the pleasure it gave him to be there as the representative of America, and thanking the society for the honor they had conferred upon his country in the person of Professor Michelson.

SCIENTIFIC NOTES AND NEWS

WE regret to record the death of Edward Williams Morley, professor of chemistry at Western Reserve University from 1869 until his retirement as professor emeritus in 1906. Dr. Morley, who was eighty-five years of age, was president of the American Association for the Advancement of Science in 1895.

THE council of the University of Paris has decided to confer the honorary degree of doctor of medicine on Professor W. W. Keen, of Philadelphia, and Professor Golgi, of Pavia.

THE council of the Royal Society has recommended for election the following: Dr. E. D. Adrian, university lecturer in physiology at the University of Cambridge; Dr. W. Lawrence Balls, chief of the experimental department of the Fine Cotton Spinners' Association; Dr. Archibald Barr, regius professor of civil engineering and mechanics in the University of Glasgow from 1889 to 1913, now chairman of Barr and Stroud, Ltd., Glasgow; Dr. C. H. Desch, professor of metallurgy in the University of Sheffield; Dr. E. Fawcett, professor of anatomy in the University of Bristol; Dr. F. Horton, professor of physics in the University of London; Dr. R. T. Leiper, professor of helminthology in the University of London School of Tropical Medicine; Professor J. W. McBain, physicist and chemist; Dr. J. J. R. MacLeod, professor of physiology in the University of Toronto; Dr. G. A. K. Marshall, director of the Imperial Bureau of Entomology; Sir Douglas Mawson, leader of the Australasian Antarctic Expedition, 1911-1914; Dr. W. H. Mills, chemist; Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B. C.; Dr. R. H. Procter, emeritus professor of applied chemistry in the University of Leeds, and Dr. W. Wilson, professor of physics in the University of London.

MAJOR WILLIAM CAIN, Kenan professor emeritus of mathematics in the University of North Carolina, has been awarded by the American Society of Civil Engineers the J. James R. Croes Medal for his paper on "The circular arch under normal loads."

A DINNER was tendered Dr. Emanuel Libman on February 23 by his associates and pupils as a tribute to his twenty-five years of active service as associate pathologist to Mount Sinai Hospital, New York City. Dr. Frederick S. Mandlebaum, pathologist of the hospital, was toastmaster. Following the dinner, it was announced that a fund of $25,000 had been completed to found the Emanuel Libman fellowship in pathology.

DR. JOHN B. DEAVER, former professor of surgery in the School of Medicine of the University of Pennsylvania, has been elected emeritus professor of surgery.

PROFESSOR LESTER P. BRECKENRIDGE, chairman of the department of mechanical engineering of Yale University, will retire from active teaching at the end of the present year. Professor Breckenridge went to Yale University from the University of Illinois fourteen years ago.

THE University of Cambridge will confer the degree of M. A., *honoris causa,* on Mr. Humphry Gilbert-Carter, director of the botanic garden.

THE Foulerton Award of the British Geologists' Association for the year 1923 has been given by the council to Mr. A. S. Kennard. We learn from *Nature* that Mr. Kennard was associated with Mr. M. A. C. Hinton in the paper on "The relative ages of the stone implements of the lower Thames valley," and

with Mr. B. B. Woodward in the production of several important papers on the Post-Pliocene non-marine mollusca of England and Ireland.

The Prix de Carthage, a biennial prize founded in 1921 for scientific or historical work, has been awarded to Dr. Nicolle, of the Pasteur Institute of Tunis, for his investigations of typhus fever, kala-azar, trachoma and Malta fever.

Señor Don José Serrato, who was elected president of the Uruguayan Republic last November, has now entered upon his work. Señor Serrato is a surveyor and engineer, having been professor in the faculty of mathematics in the University of Montevideo.

Charles R. Mann, since 1917 an educational adviser to the war department, formerly associate professor of physics in the University of Chicago, has been appointed director of the American Council of Education.

Professor E. I. Terry, of the department of biology at Middlebury College and manager of the Battell Forest, has resigned his position to accept a position as forester of the Massachusetts Forestry Association.

Richard V. Ageton, of the Bureau of Mines, who has been doing examination work for the War Minerals Relief Commission, is acting as assistant chief mining engineer of the bureau.

Edgar S. Ross, for a number of years engaged in research dealing with production of metallic tantalum and columbium, has accepted an industrial fellowship at the Mellon Institute of Industrial Research, University of Pittsburgh.

Professor W. L. Badger, professor of chemical engineering, University of Michigan, Ann Arbor, Michigan, is taking a year's leave of absence beginning February 1. He expects to continue his research work on evaporator design in Ann Arbor.

Dr. John C. Merriam, president of the Carnegie Institution; Dr. Marshall H. Saville, director of the Heye Museum, and Mr. William Barclay Parsons, chairman of the Archeological Institute of Yucatan, have been visiting Yucatan with a view to instituting investigations on the Maya civilization.

Senator E. F. Ladd, formerly professor of chemistry and president of the North Dakota College, who plans to visit Russia this summer.

Professor Elmer S. Riggs, of Chicago, is heading the Chicago Field Museum expedition which has left Rio Gallegos, in South Argentina, for a five-year exploring trip in the heart of Patagonia.

Professor S. D. Townley, who during the present quarter has been working at the Harvard College Observatory preparing a catalogue of the variable stars, returns to Stanford University this month.

Miss Mina L. Winslow, curator of mollusks in the zoological museum of the University of Michigan, will leave for Europe in the near future to study in the various museums.

Dr. Vernon Kellogg, of the National Research Council, gave a series of three lectures at Princeton University on March 13, 14 and 16, on the Louis Clark Vanuxem Foundation, under the title "Kinds of mind." The lectures reviewed the present status of knowledge of the influence of heredity in determining the character and capacity of mind in the lower animals and man. They will be published in book form by the Princeton University Press.

UNIVERSITY AND EDUCATIONAL NOTES

A bill has recently been passed by the Oregon legislature and signed by the governor appropriating $200,000 to the University of Oregon Medical School at Portland for maintenance for the next biannum. This appropriation bill was one of the few that were not cut by this legislature. At present the school has an enrollment of about 200 students and requires three years of collegiate premedical work for admission.

The Cheney Brothers, silk manufacturers, of South Manchester, Connecticut, have offered to pay Yale University $1,000 a year for two years for a fellowship in organic chemistry in the graduate school.

For the purpose of furthering research in engineering, Mrs. Mary E. Bell has offered to Cornell University a memorial in honor of her son, Harold Ingersoll Bell, who was graduated

from the College of Civil Engineering at Cornell in 1905 and died in New York City two years ago. The memorial is in the form of an endowment fund of $5,000, the income from which shall be used to purchase equipment and supplies for research in hydraulic engineering and related fields.

SIR NORMAN WALKER, of Edinburgh University, Scotland, has offered the College of Medicine at the University of Iowa his medical library through Dr. Walter L. Bierring, Des Moines. Sir Norman visited the university two years ago in company with a commission of eminent European physicians and surgeons. He has announced that the gift is in appreciation of the medical work being done at the university. He also states that he expects to send his son to the University of Iowa to complete his medical training.

A COLLOIDS research laboratory in the University of Manchester has been established with £11,842 given for that purpose. Mr. D. C. Henry, at present a lecturer in chemistry, has been appointed lecturer in colloid physics and will take charge of the laboratory, which will be known as "The Graham Research Laboratory."

DR. GEORGE GRANT MACCURDY, curator of anthropology and assistant professor of prehistoric archeology in Yale University, has been promoted to professorial rank with the title of research associate.

DR. HUDSON BRIDGE HASTINGS, of Wellesley Hills, Massachusetts, who has been investigator of business and economic questions under the Pollak Foundation for Economic Research, has been appointed professor of administrative engineering at Yale University.

MR. J. L. SHELLSHEAR, demonstrator in anatomy at the University College, London, has been appointed professor of anatomy at Hongkong, China.

DISCUSSION AND CORRESPONDENCE

AN EXCEPTIONALLY DARK DAY IN NEW YORK

AT rare intervals days occur in New York of such exceptional darkness as to attract general attention. A remarkable day of this kind was February 28, 1923.

The morning dawned dark, with a few flakes of snow falling until about nine o'clock. The darkness increased toward noon. It was most intense from nine until eleven. At that time the aspect of the city was that which might be expected at night. The shops and shop windows were lighted. Offices, even on the highest floors of the skyscrapers, found it necessary to turn on the electric light. The street cars and taxicabs were lighted as in the evening. For an hour there seemed to be no change in the density. After noon there was a perceptible improvement; but the whole day was unusually dark.

The next day was bright and clear, with a good westerly breeze. It was possible to compare the light on the dark day with that on a normal one. Print could be read as well at 6:15 P.M. on March 1 as at 10:45 A.M. on February 28. Sunset was at 5:46 on March 1. In other words, the light at a quarter of eleven in the morning of the dark day was about the same as it would normally be half an hour after sunset in the same place. The place where this comparison was made was Fifth Avenue and Forty-third Street.

In the streets the atmosphere was clear during the darkness. There was no appearance of fog. Many of the tall buildings could be seen to their tops. It was noticed that smoke and spent steam rose vertically from their roofs. The sky was dark gray.

It is seldom that even very dark days give rise to so much comment. On this occasion the public seemed to feel that it had a special reason to be alarmed. On February 28 the newspapers announced with sensational headlines that the celestial body Beta Ceti had blazed forth suddenly in the sky to the great interest of astronomers. An eminent scientist was quoted as saying that if such a change occurred in our sun, and such changes were not uncommon, the population of the earth would be annihilated. The sudden brightening was of the utmost practical importance. The dark day was therefore looked upon by thousands with alarm.

It has seemed worth while to inquire into the atmospheric conditions which prevailed at

New York and vicinity on February 28 in the hope of finding an explanation of the darkness. I am indebted to the officers of the New York office of the United States Weather Bureau for an opportunity to examine their records of temperature, pressure, wind, precipitation and fog over the northeastern part of the United States and especially along the coast in the neighborhood of New York City.

The day was seasonable as to temperature, with a maximum of 37.4 degrees Fahr. and a minimum of 30. The barometer was 29.97 at 8 A.M. and 29.89 at 8 P.M. Between ten and eleven, when the darkness was greatest, the temperature, according to the official records, was 35. This was at the top of the Whitehall Building; in the streets in the center of the city it was doubtless several degrees warmer. It may be taken as sufficiently accurate to say that the temperature throughout the very dark period was just above the freezing point.

The weather was cloudy throughout the entire region about New York, with slight precipitation in the west and north. Fog was reported along the coast from Cape Cod to the Delaware capes.

The wind was E.S.E. from 8 to 9:15 A.M., then mostly S.E. to 10 o'clock. From 10 to 10:55 it was S.S.E. At 10:55 the wind began to shift to the S., then S.W., W. and N.W. to N. It took fifty-five minutes to complete this change. From noon to 1:45 the wind blew from the north; then it veered to the N.E., back to north and was N.E. at 5:15. It blew from nearly all points of the compass, starting from the direction of the sea and continuing so until the darkest period was passed. There was a sensible lightening when the shift to the south occurred.

The velocity of the wind was five miles per hour up to 9 A.M., then 3 m.p.h. to 9:30, 2 m.p.h to 11:25 and 4 m.p.h. to noon. From noon onward to the end of the day, the velocity was from 7 to 8 m.p.h. The period of greatest darkness was the period of least wind. It grew lighter when the wind veered to the south and began to blow a little harder.

The foregoing facts appear to afford a satisfactory explanation of the darkness. During the morning, large masses of air carrying a heavy load of fog were driven very slowly back from the sea. It is probable that they encountered resistance from currents moving in the opposite direction which became noticeable later in the day, and, in consequence, became piled up to a great height. Whether it was due to this cause or not, the thickness of the fog blanket was certainly great. The warmth encountered at the surface of the earth dispelled the fog at the surface and so produced the effect of a city covered with a very heavy, low-lying cloud. When the wind shifted and grew stronger much of the cloud was blown away.

It would be interesting to know how much of the darkness was properly attributable to the smoke of soft coal and other inferior fuels due to the scarcity of anthracite coal. The smoke and fumes and dust produced by the city, and noticeable in the atmosphere, except on the brightest days, would have added materially to the darkness had there been no unusual amount of soft coal in use. The smoke added to, but did not cause the darkness.

It is proper to conclude that the darkness was caused by a great, low-lying and nearly stationary cloud into which countless chimneys were pouring smoke of various degrees of density.

GEORGE A. SOPER

THE MASS LAW AND STATISTICAL EQUILIBRIUM

THE recent note by Professor Neuhausen[1] on the reaction of slightly soluble salts calls attention to the fact that, while in the past the common error has been to apply the mass law to solutions too concentrated, it is equally fallacious to attempt to reason from it when the solutions are too dilute. Gibbs pointed out that thermodynamics is only an approximation to the exact science of statistical mechanics, the approximation being the better the larger the number of molecules in the system under consideration. Thus by extrapolation from the data for the vapor pressure of tungsten at high temperatures we can calculate the vapor pressure of tungsten at temperatures where there should be only one tungsten atom per liter in the vapor in equilibrium with the solid.

[1] SCIENCE, N. S., 57-26, 1923.

Such a calculation may have thermodynamic significance in some cases but it would be absurd to say that a tungsten wire maintains a statistical equilibrium with an atmosphere around it of one atom per liter. The absurdity becomes more obvious when we consider that a very high vacuum contains 10^{10} molecules per liter.

Similarly any calculation from thermodynamic data that one mercury ion exists per 1,000 liters is quite meaningless. If the precipitated mercuric sulfide is in statistical equilibrium with the solution, as appears probable, the absolute number of mercury and sulfide ions per cubic centimeter of solution must still be very great. It is almost an axiom of nature that gross experiments can not give us evidence as to the presence of a single ion or molecule in a given portion of matter.

The question as to the reaction of solutions with solids is answered by the knowledge of the structure of polar crystals furnished by X-ray methods. Since the ions are shown to exist as such in the crystal, the mechanism of reaction is not different than in solution. It is probable that a salt goes into solution one ion at a time although recombination may take place between ions after they are in solution.

WORTH H. RODEBUSH

UNIVERSITY OF ILLINOIS

"WHAT IS A PLANT?"

IN SCIENCE for February 9 Professor Martin in an article on "What is a plant?" laments his unsuccessful attempt to find a suitable definition of a *plant* "when introducing the subject of botany to college classes."

Assuming that one can be found, is it necessary that the beginning student learn the definition of a plant? Will he know anything more about a plant after learning the definition than he knew before? It seems a bit illogical to attempt definitions before the student has any basis for them. When the word *plant* is mentioned, most beginning students, I imagine, think of some such organism as a tree, a bush, a weed, or a grass. And at that stage of the game such a conception seems far more desirable than an abstract one involved in a definition covering organisms the student has never seen and embracing ideas for which he has no data to support.

Suppose we let undisturbed the student's "indefinite" conception of a plant. Let him find out by laboratory exercises or field work how his "plant" is constructed. Show him by experiments how his "plant" lives, manufactures its food, grows and reproduces. Let him study and get similar data for ferns, mosses, liverworts, algae, fungi, bacteria. All this time he will have been learning *about* plants, their similarities and differences, their processes, their habitats, their relations to him. It appears that then, and only then, will the student be in a position to appreciate plants, their evolution, their relationships and their classification. It will require little effort on the part of the instructor for the student to realize that his earlier conception of a plant needs considerable modification.

If a plant must be defined, let us wait until the student has seen some illustrative material; until he has learned something about processes and structures of things he has no hesitancy in calling plants; and until he has made his own observations on some of the different organisms we call plants. At that time the student will be able to make his own definition based on what he has observed. Such a definition will not only not be abstract and beyond his grasp, but will be his *own*—of tremendous pedagogical significance.

L. H. TIFFANY

THE OHIO STATE UNIVERSITY

THAT PLANT

SOME ten years ago a high school girl wrote to me asking for a definition of a plant. Probably she wanted to floor some opponent in an approaching debate. After racking my brain for several days I wrote, "A plant is a living thing which manufactures its own food from the raw materials of earth and air, or one whose ancestors did so." I have used this definition ever since in my botany classes, but rather as a joke than as a serious matter. But the students take it seriously enough and usually commit it to memory. In substance it is obviously identical with that proposed by Professor Martin (SCIENCE, February 9, 1923), only mine is more prolix. If one must have a definition, I know of nothing better. It is particularly useful in showing that definitions are at best a mere makeshift, and very dan-

gerous. Sometimes I insert after the word air "by the agency of light and chlorophyll." The clause relating to ancestors, however, makes the diagnosis of a plant quite impossible, and indeed introduces some very hypothetical material. We try to reach the conclusion that the statement of a real definition requires the contents of at least one book on general botany, with suitable lectures and laboratory experience or field work, and that the definition can be improved by more and more of such study. If there is a better definition, let us have it.

HENRY S. CONARD

GRINNELL COLLEGE

"EROBIC"

I HAVE read with very great interest the article on the "Bacteriology of Influenza," but I want to make one suggestion in reference to the spelling of "Erobic" and "Anerobic." This, it seems to me, ought to be "Ærobic" and "Anærobic."

I am fully converted to the use of the "e" instead of "æ" and "œ" as a rule, but in "erobic," for instance, "er" misleads one as to its meaning, as it comes from the Greek "ær." The same is true of "anerobic." It seems to me very clear that "æ" should be retained in this case, as an exception.

I confess, when I first read "erobic," I wondered what the word meant. My first idea was of an obscure reference to "eros" in "erobic." I was quite misled, and it took me an appreciable time to determine that it meant "ærobic." I hope that the spelling of these two words in this number of SCIENCE will not be continued.

I am a member of the consulting committee of the Simplified Spelling Board, and therefore am prejudiced in favor of the "e" instead of "æ" or "œ," but this, I think, goes beyond the mark that even the Simplified Spelling Board justifies.

W. W. KEEN

PHILADELPHIA
FEBRUARY 15, 1923.

QUOTATIONS

GIFT TO THE ROYAL SOCIETY

THE magnificent gift, which we announce this morning, by Sir Alfred Yarrow to the nation, through the Royal Society, of £100,000 for the advancement of scientific research should serve two purposes. It should be of most substantial help to numbers of investigators who are hampered or depressed by want of funds, and, as it throws the heavy responsibility of administration upon the Royal Society, it should serve to rehabilitate the illustrious institution in the eyes of those who are concerned not so much with science itself as with the politics of science. To touch on this second point first. There can be no question that Sir Alfred Yarrow, who is himself an honored member of the Royal Society, has done wisely in entrusting his fund to the society, for there is no other body possessed of traditions, prestige and authority to equal it in the kingdom, or, indeed, in the world. But of late years there has been a strong disposition to criticize the society's attitude towards the practical affairs of life. It has been felt that it has often preferred a dignified position of aloofness towards current interests, and it has seemed to let go by default some of its unique claims to be the real leader and adviser of the nation in scientific administration. It ought, one might argue, to be the invariable channel through which private benefactions to science should be directed. It ought to have a controlling voice in the application of government grants for scientific purposes; it ought, in short, to be as thoroughly active in practical matters as its individual members are in their own spheres of study. The obligations which this princely endowment now casts upon it should help substantially to enhance its authority. From this point of view alone Sir Alfred Yarrow's gift will, we believe, be welcome; for the Royal Society is of such a composition that its voice can never be negligible; its opinion on all matters connected with science must always be of paramount influence, and no one who has the interests of science or of knowledge at heart would care to see it miss its opportunities. We urged considerations of this kind last December, when the new council was appointed; and now the society has a brilliant opportunity of making good the ground that some of its sincerest well-wishers may have feared that it had lost.

As for the need of such an endowment for

research there can be no question. The nation is not nearly scientific enough, or, to say it plainly, does not know nearly enough. Yet on knowledge, and on the pursuit of knowledge, the welfare of its citizens and the prosperity of its industries increasingly depend. Sir Alfred Yarrow's reasons for making this gift for scientific research are stated in his letter, and they are incontestable. He recalls the dangers to which lack of science, or ignorance, exposed us in the war and the advantage which the country reaped then and before from the labors of its scientific investigators. This testimony to "pure" science, as it is called, is all the more forcible in that it comes from a mind which has been devoted over many years not only to the application of acquired knowledge in shipbuilding and engineering, but also to its theoretic extension in the laboratory. It is on quiet laboratory work that everything in the long run depends. The Royal Society by its rules and traditions consists chiefly of persons engaged in the pursuit of knowledge for its own sake, and they are therefore least likely to be misled by the desire for immediate fruits. Sir Alfred Yarrow has left the society free as to the mode in which the capital or the income of his gift is to be expended, but he declares his preference for the adequate payment of scientific workers and for the provision of apparatus and facilities rather than the erection of costly buildings. He recognizes that conditions may alter from time to time, and suggests that if rules are framed for the administration of the fund, these should be revised at least every ten years. The suggestions are as prudent as the gift is generous. The nation will expect the Royal Society to translate into action the wise intentions of the donor with corresponding sagacity.—*The London Times.*

SCIENTIFIC BOOKS

DR. JORDAN'S AUTOBIOGRAPHY[1]

DR. JORDAN has chosen a most apt title for his autobiographical volumes. It is a "man," in the meaning of the accented use of the word, of whose life from childhood to seventy we are told in this book; and the activities and achievements of this life are revealed rather in the form of a record of the succeeding days and days' work of this life, with all their crowding and various activities of student, teacher, scholar, administrator and publicist, than in the form of an organized grouping of these activities and interests according to subject. This manner of treatment, chronological, inclining toward the diary form, has its drawbacks of diffuseness and mixing of subject matter and, one must perhaps admit, of overmuch detail, to the reader interested primarily in one or more of those important subjects, such as reform in university methods, introduction of the evolutionary point of view into the teaching of biology, the relations of science to every-day life, the encouragement of internationalism and pacifism, and what not else to which Dr. Jordan has so valuably contributed. But it has its great advantages to the reader interested in following closely the development and unremitting activity of a great personality. It reveals the methods of a highly intelligent and informed man, of robust, forthright character, working always with a steadfast aim to be useful to the youth and to the public and government of the American nation; the methods of a man intent on making use of every least as well as largest opportunity, with entire disregard of personal advantage or hurt, to contribute up to the very limit of his power to the advancement of the higher civilization of America and the world. As such it is a fascinating, stimulating and really ennobling record of the "days of a man."

Dr. Jordan tells interestingly of his childhood, in a manner always influenced, but never deadened, by the scientific student of heredity. He describes his days as pupil at home in the village of his birth in Western New York, then in a near-by academy, and finally as college student, beginning with seventy-five dollars in his pocket, at Cornell. His double interest in science and literature, maintained all through life, revealed itself from the beginning of his days of understanding. This story of adolescent development is seizing; one wishes there were more of it.

[1] *The Days of a Man*, being memories of a naturalist, teacher and minor prophet of democracy. By David Starr Jordan; two volumes, illustrated, 1922. World Book Company, Yonkers-on-Hudson.

It was in the Cornell days that he made those important contacts and friendships with a group of young men devoted to scientific study, among them Branner, Comstock, Dudley, Copeland, and Kellerman, which had a lasting influence on his life. And it was at Cornell that he came to know its famous first president, Andrew D. White, who was to have such an important part in determining his selection as the first president of Stanford, and such an influence on Jordan's own attitude and efforts as university president in Indiana and California.

In 1873, Dr. Jordan, only just graduated from Cornell, was a member of that famous first, and only, summer class of Louis Agassiz on Penikese Island. (A second class, of which Jordan was also a member, was held next summer under the direction of Alexander Agassiz and Burt G. Wilder. This ended the Penikese Island experiment.) Here young Jordan came to know Brooks, Whitman, Minot, Faxon, Fewkes and others, all since famous in scientific annals. Agassiz made a great impression on Jordan, probably the greatest impression ever made on him by any man of science. One constantly meets references to Agassiz and his point of view and methods all through Dr. Jordan's two volumes.

After Penikese, begins the record of the days of the teacher and investigator of natural history in various collegiate institutions, as well as of the work of the wide-travelling field naturalist already specializing in ichthyology, a special interest which has been maintained to the very present day. His first fish-hunting trip to the South came in 1876; he made a second trip there in the next year and still a third in 1878. It was in 1877 that he made his first trip to Washington, becoming acquainted there with Baird, Gill, Coues, Dall, and Ridgway, the result of which was to make connections with the Smithsonian Institution which, with later connections made with the U. S. Bureau of Fisheries, were to give him unusual opportunities for the faunistic and taxonomic work on American fishes that soon resulted in making him the first American authority in this field.

In 1879 Jordan became professor of natural history in the University of Indiana. He taught botany, zoology, physiology and geology. This was only forty years ago. Now Indiana has a department of botany with one professor and three associate professors, a department of zoology with three professors and one assistant professor, a department of physiology with one professor and one assistant professor, and a department of geology with two professors, one associate professor and two assistant professors.

In 1880 Dr. Jordan made his first trip to California and the Pacific Coast. The first of his many trips to Europe was made in 1879. On January 1, 1885, he became president of Indiana University. In 1891 he was chosen by Senator Leland Stanford and his wife, the founders of Leland Stanford Junior University, to be its first president. It was a privately endowed university established, under extraordinary conditions, on the west shore of the long southern extension of San Francisco Bay, about thirty miles south of the city of San Francisco, in the middle of a great grain and stock ranch where fast trotting horses were being bred. Dr. Jordan had been recommended to the Stanfords for this position by Andrew D. White of Cornell.

So much, and perhaps too much for the fair balancing of this review, concerning the events in Dr. Jordan's life recorded in the first half of the first volume of the "Days of a Man." But the events of the days from 1881 to the present, told in the remaining three quarters of the book, are more familiar to us. They need no such detailed cataloging. It is in these thirty years of never abated activity as educator, scientist and publicist, that Dr. Jordan won his present national and international reputation. From 1893 on I have known him intimately, admiringly, reverently. I have been privileged to work with him in classroom and field, and to play with him in mountains and tropic islands. His active brain, ever driving him and all of us around him to constant effort; his freedom from convention and hampering tradition; his intelligent progressivism; his high honesty to his high ideals; his saving grace of humor; his active sympathy with all aspiring youth; his philosophic grasp of the one essential, truth, as a basis for all philosophy of action; all these traits explain his achievement

as "naturalist, teacher and minor prophet of democracy." He has been great in all these characters.

The story of his highly successful development, in the face of seemingly insuperable obstacles, of Stanford University; of his contributions to internationalism by his services as official representative of the United States in connection with the solution of the fur seal problem and as unofficial but powerful representative of this country on many visits to Japan, Australia, and Europe; his consistent struggle against the Gods of War through a period where these Gods had their way with mankind; the stories of all these are illuminatingly told in the "Days of a Man." They are all inspiring; they all point the way toward human advancement; they all make one eager to go and try to do likewise. The "Days of a Man" is a good book for youth to read, and a good book for men and women, eager to help in the progress of humanity but occasionally discouraged by their hard contacts with the inertia and sordidness of much of our governmental and educational politics, to have conveniently at hand from which to draw new encouragement and determination.

VERNON KELLOGG

NATIONAL RESEARCH COUNCIL
WASHINGTON, D. C.

SPECIAL ARTICLES

USE OF THE CARBON DIOXIDE FREEZING ATTACHMENT ON THE ROTARY MICROTOME

SEVERAL years ago in the *Botanical Gazette* (Vol. 63, pages 236-239, 1917) Professor N. L. Gardner described a method for securing sections of various plant objects easily, quickly, and in large numbers by means of a brine-cooled microtome stage mounted on a rotary microtome. This apparatus has proven particularly useful in preparing sections of fresh leaves, or other living plant objects containing little woody tissue, for study by students in general botany. When sections prepared by this method are examined within an hour or two of cutting, the cells show no evidence of injury from the short exposure to low temperature. They appear to be in all respects equal to fresh free hand sections and are superior in that they are complete and much thinner than those usually secured by hand sectioning.

There are two serious disadvantages, however, in using this method in preparing sections for a large class. First, the preparation of the ice, its mixture with salt, and the charging of the containers which deliver the brine to the freezing chamber are rather arduous and time consuming tasks and second, if laboratory classes are spread over four or five days each week it is necessary either to charge the apparatus with ice and salt on several occasions in order that fresh sections may always be available or to use sections which have been cut for several days. Such sections are entirely unsatisfactory even if kept on ice.

It had occurred to the writer that, in place of the brine freezing attachment, a carbon dioxide freezing attachment might be connected to a rotary microtome and that thus both of the disadvantages mentioned might be avoided. The only objection which presented itself was that the short metal tube of the carbon dioxide attachments furnished by the dealers in microtomes might prove so rigid as to interfere with the free movement of the microtome stage on the rotary microtome and thus cause considerable irregularity in the thickness of the sections and perhaps injure the microtome. To avoid this the tube of a Spencer Carbon Dioxide Freezing Attachment was separated from the threaded connections for the CO_2 tank and microtome stage, and in its place was brazed a ten-foot length of one quarter inch, a one thirty-secondth inch wall copper tube such as may be secured for a small sum from any dealer in automobile garage supplies. The greater length of this copper tube and its somewhat greater flexibility permitted such freedom of movement of the freezing chamber that the latter could be safely attached to the rotary microtome and sections of uniform thickness could be secured. This application of carbon dioxide freezing to the rotary microtome has proved entirely satisfactory and much more economical than brine freezing except where cutting is to be continued without interruption over a period of three or four hours.

With the rotary microtome and CO_2 freezing attachment set up in the preparation room adjoining the elementary laboratories it is now

possible for an assistant within five or ten minutes to prepare the material, freeze it, and cut enough sections for several hundred students. With very little expenditure of time and energy fresh sections can be provided for all laboratory classes.

The material is frozen in a small quantity of relatively thick gum arabic solution. The temperature which must be used to convert this mucilage into a firm supporting mass is apparently not sufficiently low to cause visible injury to living plant tissues by freezing.

A feature which adds much to the convenience of the method is the use of a small wooden block, described in Professor Gardner's article. This block is so cut away on one side as to form with the microtome knife to which it is fastened by means of a wire clamp, a chamber into which the sections fall as they are cut from the frozen mucilage mass. The chamber is partly filled with water, the contact of the block with the knife is made water tight by means of a thin layer of vaseline. When cutting is completed the sections may be easily poured from the chamber with the water.

It is perhaps not superfluous to add that sections thus cut are given to the student for study only after he has cut and examined free hand sections of the same material.

RICHARD HOLMAN

UNIVERSITY OF CALIFORNIA

THE AMERICAN MATHEMATICAL SOCIETY

THE two hundred and twenty-seventh regular meeting of the American Mathematical Society was held at Columbia University, New York City, on Saturday, February 24, extending through the usual morning and afternoon sessions. The attendance included thirty-five members of the society.

The secretary announced the election of twenty-six persons to membership, and the entrance into the society since the annual meeting of seven additional members of the London Mathematical Society under the reciprocity agreement.

At the meeting of the council, the secretary announced the appointment by President Veblen of a committee on endowment, with Professor J. L. Coolidge as chairman. A committee on arrangements for the summer meeting at Vassar College was appointed consisting of Professors H. S. White *(chairman)*, G. M. Conwell, E. B. Cowley and L. D. Cummings and the secretary. Professor E. V. Huntington was appointed representative of the society in the Division of Physical Sciences of the National Research Council for the period of three years beginning July 1, 1923.

The following papers were read before the society at this meeting:

Circular plates of constant or variable thickness: C. A. GARABEDIAN.

Permutable rational functions: J. F. RITT.

The maximum number of cusps of a space curve: T. R. HOLLCROFT.

Theory of the octavic: A. M. WHELAN.

Analogy between electromagnetic field and analytic function: G. Y. RAINICH.

The existence of closed geodesics on surfaces. Preliminary communication: J. W. ALEXANDER.

The asymptotic expansion of the functions $W_{k,m}(z)$ of Whittaker: F. H. MURRAY.

Some geometric applications of symmetric substitution groups: A. EMCH.

A property of Haar's system of orthogonal functions: J. L. WALSH.

The Riemann adjoints of certain completely integrable systems: C. A. NELSON.

Intermediate curvatures in Riemann space: E. KASNER.

Concerning the common boundary of two or more regions: G. A. PFEIFFER.

Some theorems on insolvable groups: L. WEISNER.

Values in terms of Bernoulli and Eulerian numbers: I. J. SCHWATT.

On the reduction of differential parameters in terms of finite sets. Preliminary report: O. E. GLENN.

A new form of Stirling's interpolation formula: G. RUTLEDGE.

On the angle between two curves in V_n: J. LIPKA.

On the accessibility of the boundary of a domain: R. L. WILDER.

Determinantal relations based on a matrix whose elements fall into two classes: L. H. RICE.

Maximum modulus of some expressions of limited analytic functions: S. KAKEYA.

The society will meet at the University of Chicago April 13-14 and at Columbia University April 28.

R. G. D. RICHARDSON,
Secretary